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ABSTRACT

Dry-land training in preparation for competitive cross-country skiing proved to be effective in increasing athletes' aerobic capacity and physical fitness. Such training included bicycle racing, roller skiing, fartlek running, cross-country running, simulated ski walking on inclines, and interval training over hills. (JD)

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FITNESS LEVELS OF UNIVERSITY CROSS-COUNTRY SKIERS *

by

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FITNESS LEVELS OF UNIVERSITY CROSS-COUNTRY SKIERS

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In an attempt to contrast fitness indices of U.S. Nordic Skiers (Hanson, J APPL PHYSIOL, 1973) to university skiers, physiological responses of the Men's University of Utah Cross-Country Ski Team (N = 3) were assessed at the end of dry-land training.

The skiers reported to the laboratory postprandial wearing shorts and shoes. Percent body fat was determined by the method of Zuti and Golding. Lung volumes and capacities were assessed using a respirometer. Following a five minute sitting rest period, subjects walked on a motor-driven treadmill at 100 m $\cdot$ min^{-1} (3.7 mph) with an 1 % increase in slope each minute until volitional exhaustion, achieving maximum oxygen consumption. Minute-by-minute measurements for oxygen consumption were made using standard open-circuit, indirect-calorimetry techniques. Oxygen debt was determined from values obtained during a 15 minute sitting recovery at the end of the walk.

Comparative results (maximum values, where appropriate) are presented (means):

	Age (yr)	Ht (cm)	Wt (kg)	BSA (m^2)	Fat (%)	LBW (kg)	TLC (L)	VC (L)	FRC (L)	RV (L)
Hanson, 1973	26.3	181.2	73.1	1.93	8.9	66.6	8.2	6.1	4.4	2.2
This study	20.3	181.7	73.0	1.93	11.6	64.5	7.2	5.8	3.8	1.4
p	> .05	> .05	> .05	> .05	< .05	> .05	> .05	> .05	> .05	< .05

	VEBTPS (L $\cdot$	VO2 min^{-1})	VCO2	HR ($b \cdot min^{-1}$)	O2 Pulse ($ml \cdot b^{-1}$)	FEV .5 (%)	FEV 1.0 (%)
Hanson, 1973	155.9	5.48	5.37	182.6	29.9	50.7	76.1
This study	136.2	4.90	3.84	183.7	27.3	61.0	86.3
p	> .05	> .05	< .05	> .05	> .05	> .05	> .05

Along with an O2 debt of 5.3 L, the data indicate that our subjects compare favorably with the U.S. Team. In addition, these results are serving as baseline indices for modifications of the on snow training programs in an attempt to enhance aerobic power.

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INTRODUCTION

It has been well documented as early as 1967 by Saltin and Astrand, and more recently by Astrand and Rodahl (1977) that male cross-country skiers have the highest observed aerobic capacity. In 1973, Hanson reported that members of the U.S. Nordic Ski Team, as a function of dry-land training, had attained maximal exercise responses that compared favorably with the highest values reported in the literature. Inasmuch as the University of Utah has had several All-American cross-country skiers the past few years, it seemed propitious to assess the physiological responses of the 1977-1978 team and to compare these results to the fitness indices of the U.S. Nordic Ski Team as published by Hanson (1973).

METHODS

Both our skiers and Hanson's skiers were tested at the end of about 40 days of dry-land training. Hanson stated that this included competitive bicycle racing for several of the U.S. skiers. Our university skiers participated in roller skiing, fartlek running, cross-country running, simulated ski walking on inclines, and interval training over hills.

Following an orientation to both the laboratory and to the techniques to be employed, our subjects reported to the laboratory, an average of 3.2 hours postprandial wearing shorts and shoes. Percent body fat was determined by the method of Zuti and Golding, taking measurements from the right wrist, the left pectoral skinfold, and the waist girth. Vital

capacity and forced expiratory volume at one second were measured on a respirometer. Functional residual capacity, residual volume, and total lung capacity were estimated from age and vital capacity.

Prior to the exercise measurements, a five minute period of sitting was used to obtain resting values. The skiers then walked on a motor-driven treadmill at 100 m · min^{-1} (3.7 mph) with an 1% increase in slope each minute until oxygen consumption reached a plateau as work rate continued to increase, achieving maximum oxygen uptake as described by Taylor, Buskirk, and Henschel (1955). Minute-by-minute measurements for oxygen consumption were made using standard open-circuit indirect calorimetry techniques. To determine oxygen debt, the skiers sat for 15 minutes at the end of the walk.

RESULTS AND DISCUSSION

Intense and frequent dry-land training bouts apparently were sufficient to cause positive training effects in both groups of skiers. When comparing our skiers to the U.S. Nordic Ski Team (see data presented in the abstract), we note that there were no significant differences observed between the two groups on either age, height, weight, or body surface area. However, the University of Utah Ski Team had a significantly greater percentage of body fat, 11.6% than the U.S. Ski Team, reported at 8.9%, both of which are low values. We may also note the non-significant differences between the two groups of skiers on lean body weight. In addition, our University of

Utah Ski Team compared favorably with the U.S. Ski Team on the pulmonary function measurements of Total Lung Capacity, Vital Capacity, Functional Residual Capacity, and Forced Expiratory Volume at both 0.5 and 1.0 second. Whereas, the U.S. Skiers had a significantly larger Residual Volume than our skiers.

Aerobic capacity was determined and the results are reported. There were no significant differences between the skiers tested by Hanson and those tested by us on either maximum minute ventilation or maximum oxygen consumption, expressed as $L \cdot min^{-1}$. Please note that these values place these skiers into the "elite" category of highly trained endurance athletes. Furthermore, the two groups of skiers did not differ significantly on either maximum oxygen pulse or on maximum heart rate.

Along with an average oxygen debt of 5.3 L, the data indicate that our University of Utah Cross-Country Skiers compare favorably with the results obtained by Hanson from the U.S. Nordic Ski Team. Inasmuch as Hanson in 1975 reported that the fitness levels of the U.S. Nordic Ski Team declined as the season progressed from November into April, our results served as baseline indices for modification of the on-snow training program used by the University of Utah Ski Team.

Last summer at the International Congress of Sports Sciences, Ruhling and Storer (1978, 1979) reported a case study of a three-time NCAA Cross-Country Skiing All-American, in which it was demonstrated that by altering his on-snow cross-country ski training, his fitness levels did

not decline, but, in fact, improved.

In previous years, key individuals from the University of Utah Cross-Country Ski Team had placed as high as fourth in the NCAA Cross-Country Skiing Championships. This year, having made use of the laboratory results, in an attempt to increase their aerobic capacity, the University of Utah Cross-Country Ski Team achieved a rare first and second place finish in the NCAA Cross-Country 15 kilometer race (52:40.51 min, and 53:09.74 min), which helped considerably in placing the University of Utah Ski Team second in the 1979 NCAA Skiing Championships.

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